

ENGINEERING
Electric circuits2
4/05/2011
90 m

التخصص والمستوى :
اسم المساق :
تاريخ الامتحان :
زمن الامتحان :

Circuit 2
Second



السلطة الوطنية الفلسطينية
جامعة فلسطين التقنية طولكرم "خضوري"
second exam 2010/2011

الاحلامه
21
30

21

الشعبة : اثنين اربعاء 8.00-9.30

الاسم : محن سلام محمود خدران

Q1) For the system shown below

- Find the total average power, the total reactive power, total apparent power & the power factor of the system (4)
- Sketch the power triangle of the system (1)
- Find the total supply current I_T (1)
- Determine the value of the capacitor that must be added in parallel of these loads to raise the power factor of the system to 0.95 if the frequency of the system is 60 Hz (3)
- Determine the total supply current after this correction (1)

load 1

$$P_1 = 12 \text{ kW}$$

$$F_p = 0.9 = \cos(\theta)$$

$$\theta = 25.8^\circ$$

$$F_p = \frac{P_1}{S_1}$$

$$S_1 = \frac{P_1}{F_p} = \frac{12 \text{ kW}}{0.9} = 13.3 \text{ KVA}$$

$$Q_1 = S_1 \sin \theta = 13.3 \sin(25.8^\circ) = 5.78 \text{ KVAR}$$

load 2

$$S_2 = 20 \text{ KVA}$$

$$F_p = 0.7 = \cos(\theta)$$

$$\theta = 45.5^\circ$$

$$\text{but } F_p = \frac{P_2}{S_2} \Rightarrow 0.7 = \frac{P_2}{20} \Rightarrow P_2 = 14 \text{ kW}$$

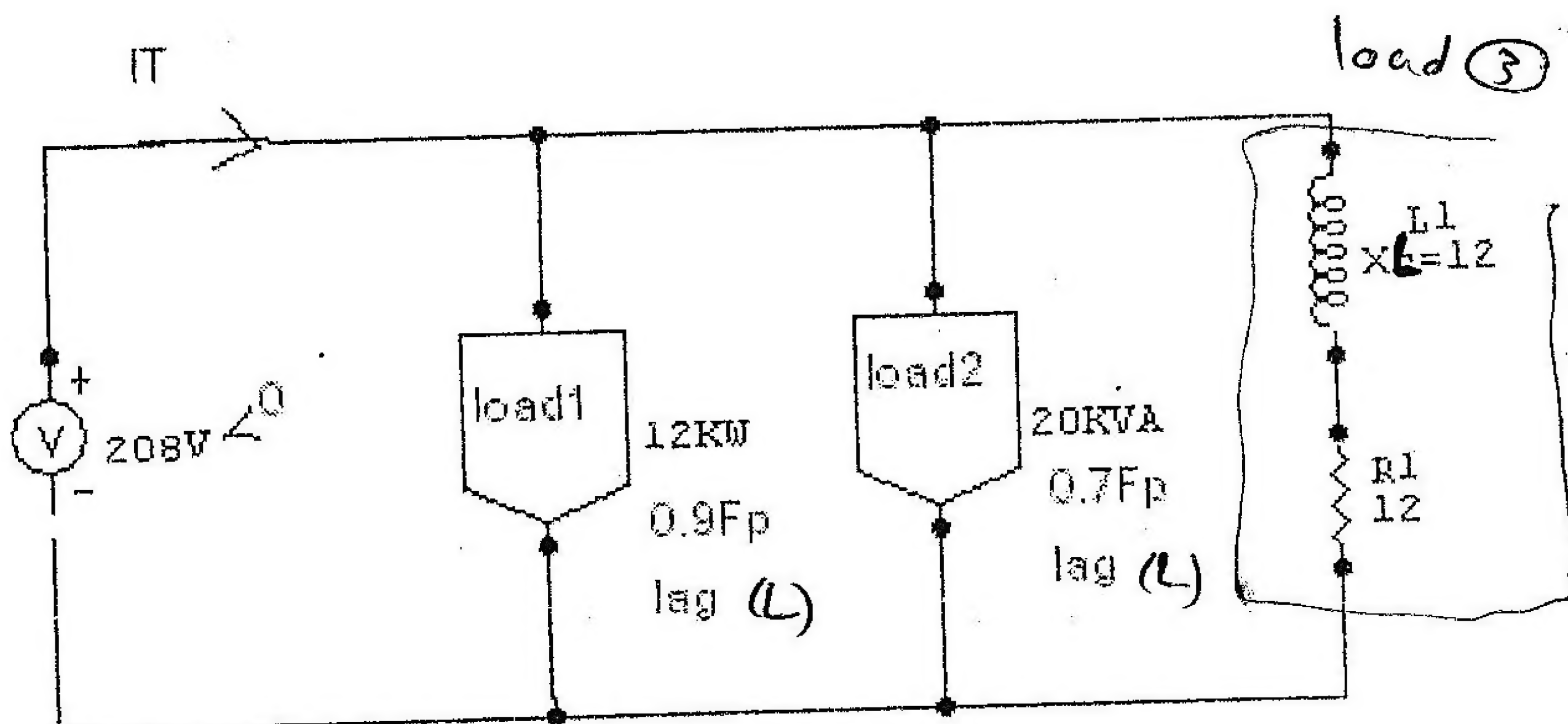
$$Q_2 = S_2 \sin \theta = 20 \sin 45.5^\circ = 14.26 \text{ KVAR}$$

load 3

$$P_3 = \frac{V^2}{R} = \frac{(208)^2}{12} = 3.6 \text{ kW}$$

$$Q_3 = \frac{V^2}{X_L} = \frac{(208)^2}{12} = 3.6 \text{ KVAR}$$

$$S_3 = \sqrt{(3.6)^2 + (3.6)^2} = 5.1 \text{ KVA}$$



تم الرفع بواسطة
م. محن ابو عيسى

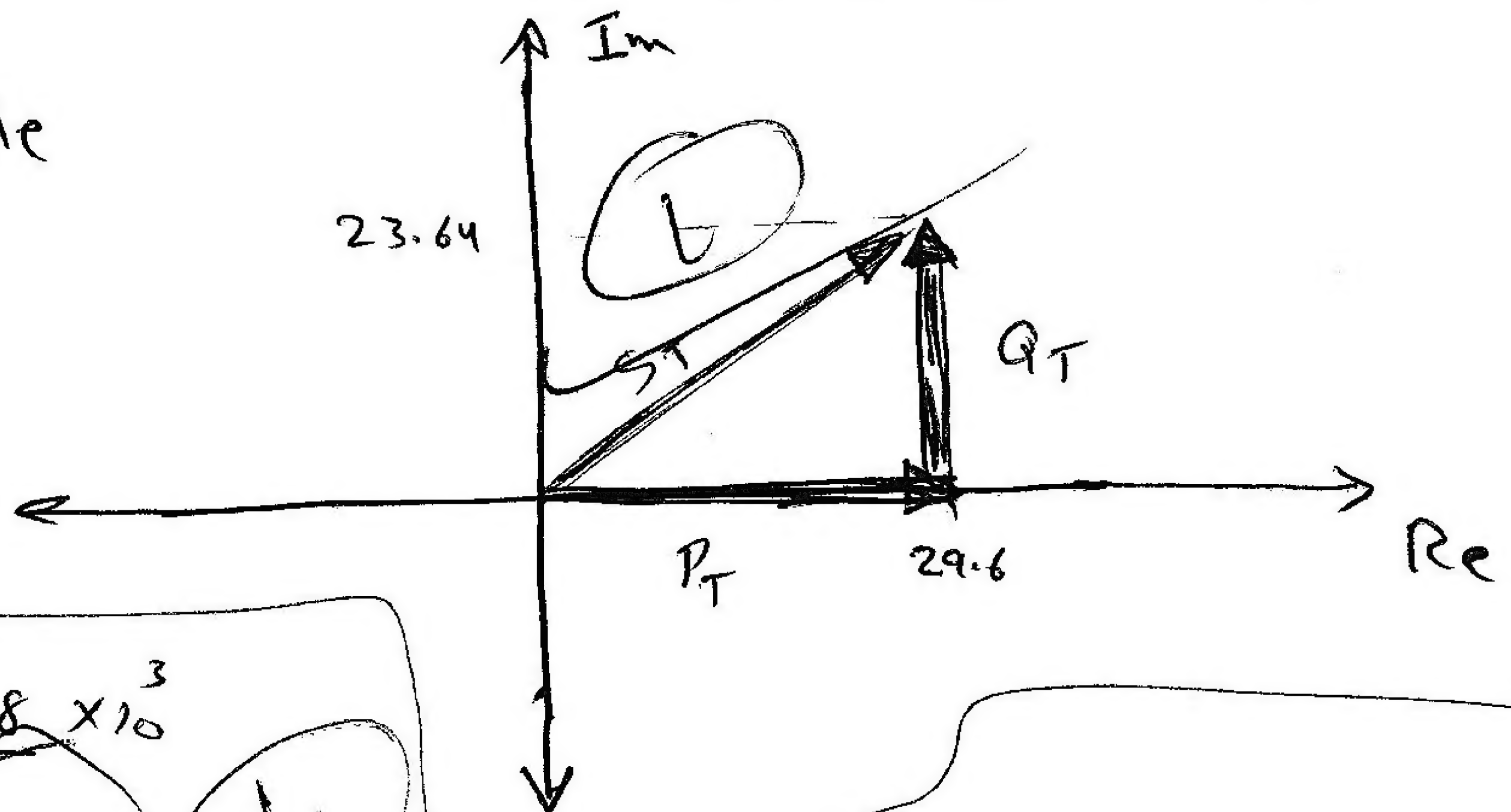
لتنع

$$P_T = P_1 + P_2 + P_3 = 12 + 14 + 3.6 = 29.6 \text{ kW}$$

$$Q_T = Q_1 + Q_2 + Q_3 \text{ (inductive)} = 5.78 + 14.26 + 3.6 = 23.64 \text{ kVAR}$$

$$S_T = \sqrt{P_T^2 + Q_T^2} = \sqrt{(29.6)^2 + (23.64)^2} = 37.88 \text{ kVA}$$

b) The Power Triangle



$$c) I_T = \frac{S_T}{V} = \frac{37.88 \times 10^3}{208} = 182.1 \text{ A}$$

$$d) F_p = 0.95 \Rightarrow \theta = \cos^{-1}(0.95) = 18.19^\circ$$

$$P_T = 29.6 \text{ kW}$$

$$F_p = \frac{P_T}{S_T} \Rightarrow 0.95 = \frac{29.6 \text{ kW}}{S_T} \Rightarrow S_T = \frac{29.6 \text{ kW}}{0.95} = 31.15 \text{ kVA}$$

$$\therefore Q_T = S \sin(18.19^\circ) = (31.15) \sin(18.19^\circ) = 9.72 \text{ kVA}$$

\therefore The Reactive Power that must be added to raise the power factor is $23.64 - 9.72 = 13.92 \text{ kVAR}$

$$\therefore Q_u = 13.92 \text{ kVAR} = \frac{V^2}{X_c} \Rightarrow 13.92 = \frac{(208)^2}{X_c}$$

$$\therefore X_c = \frac{(208)^2}{13.92 \text{ kVAR}} = 3.1 \Omega$$

$$X_c = \frac{1}{\omega C} \Rightarrow C = \frac{1}{\omega X_c} = \frac{1}{2\pi \times 60 \times 3.1} =$$

$$8.5 \times 10^{-4} \text{ F} = 0.85 \text{ mF}$$

$$e) I_T \text{ after} = \frac{S_T}{V} = \frac{31.15 \text{ kVA}}{208} = 149.7 \text{ A}$$

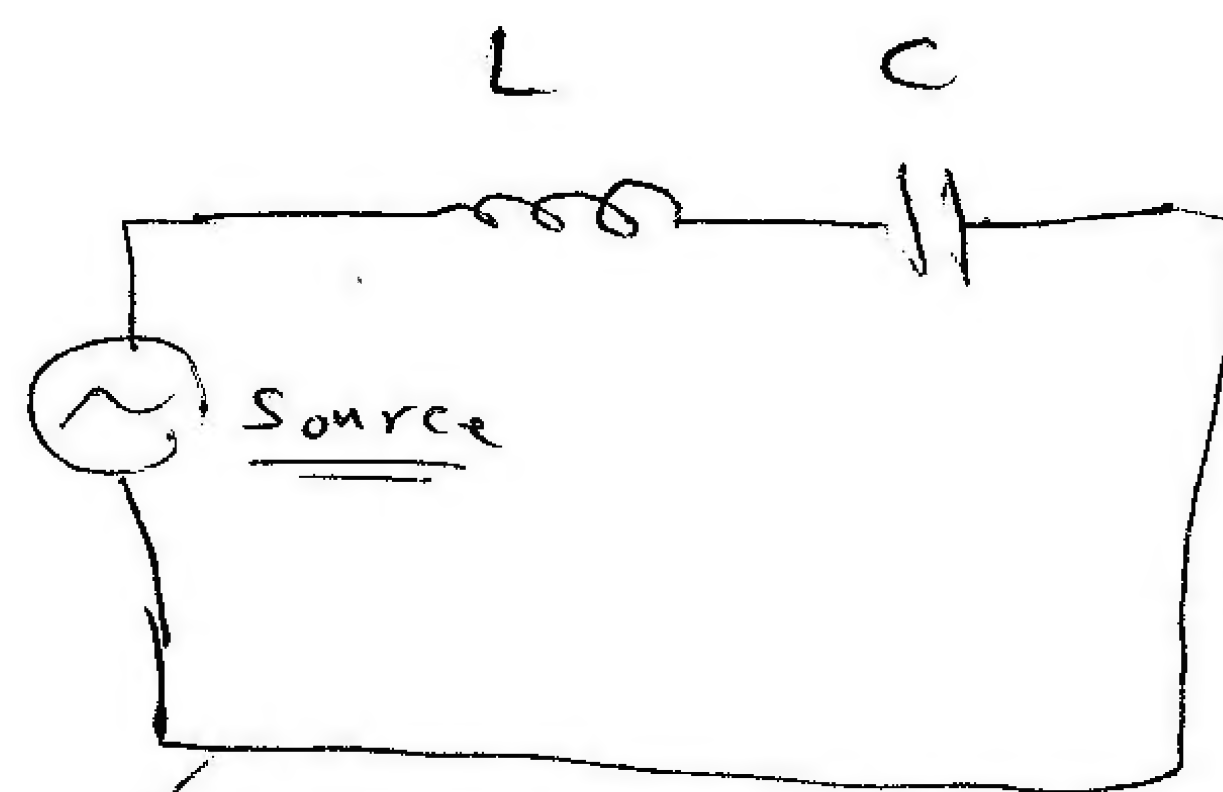
Q2) Design a series resonance circuit to have a BW of 400Hz using a coil with a $Q_L=20$ & $R_L=2\Omega$.
Find the values of L , C , f_s & the cutoff frequencies (5)

⊗ $BW = 400 \text{ Hz}$

$$BW = \frac{f_s}{Q_s} = \frac{R}{2\pi L} = \frac{R_L}{2\pi L} = \frac{2}{2\pi L}$$

⊗ $400 = \frac{2}{2\pi L} \Rightarrow L = \frac{2}{2\pi(400)}$

$$= 7.95 \times 10^{-4} \approx 0.8 \text{ mH}$$



here $Q_L = 20 > 10$

$\therefore Q_L = Q_s$

⊗ $BW = \frac{f_s}{Q_s} \Rightarrow 400 = \frac{f_s}{20} \Rightarrow f_s = 8000 = 8 \text{ kHz}$



⊗ $f_s = \frac{1}{2\pi\sqrt{LC}} \Rightarrow 8000 = \frac{1}{2\pi\sqrt{0.8 \times 10^{-3} C}}$

$$\Rightarrow 16000\pi = \frac{1}{\sqrt{0.8 \times 10^{-3} C}} \Rightarrow 16000\pi = \frac{1}{\sqrt{0.0008 C}}$$

$$\sqrt{0.0008 C} = \frac{1}{16000\pi} \Rightarrow \sqrt{0.0008 C} = 1.98 \times 10^{-5}$$

$$0.0008 C = (1.98 \times 10^{-5})^2 \Rightarrow 0.0008 C = 3.92 \times 10^{-10}$$

⊗ $\Rightarrow C = \frac{3.92 \times 10^{-10}}{0.0008} = 4.9 \times 10^{-7} = 0.49 \mu\text{F}$

⊗ $f_1 = f_s - \frac{BW}{2} = 8000 - \frac{400}{2} = 7800 \text{ Hz}$

⊗ $f_2 = f_s + \frac{BW}{2} = 8000 + \frac{400}{2} = 8200 \text{ Hz}$

Q3) For the network below

a) Find the value of X_L for resonance (1)

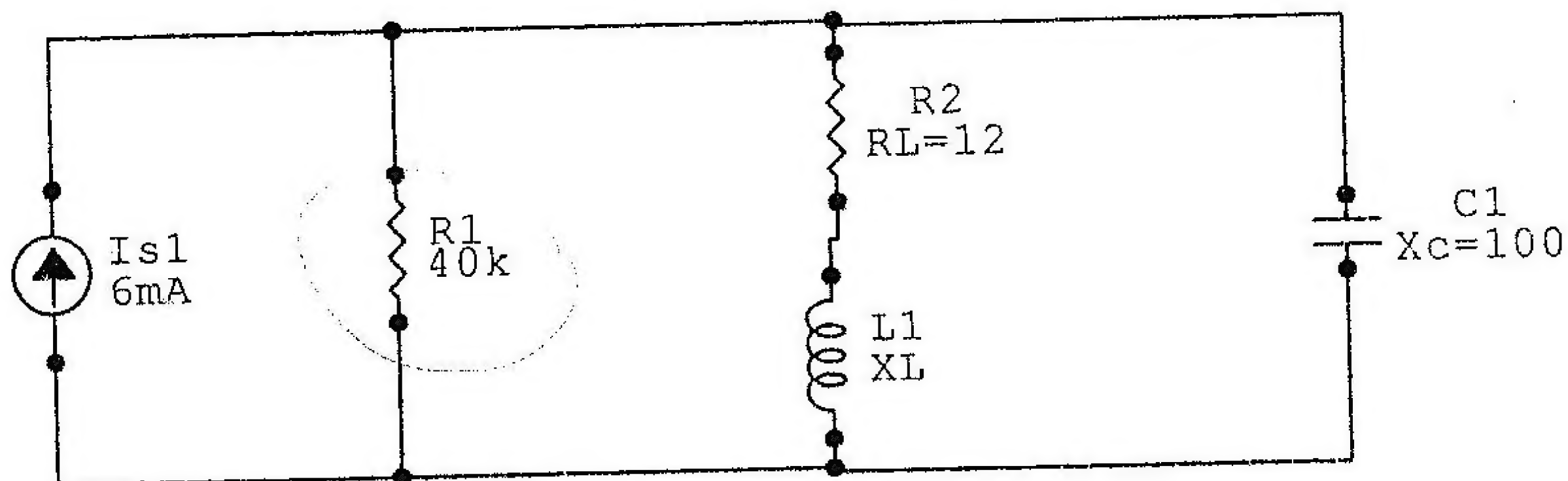
b) Find the value of Q_L (1)

c) Find the resonance frequency if the BW is 1KHz (1.5)

d) Find the maximum value of the voltage V_c (1.5)

e) Sketch the curve of V_c versus frequency indicating its peak value, resonance frequency and half power frequencies (2)

f) Find the values of I_L & I_c at resonance (1)



a) at resonance $\Rightarrow X_L = X_C \Rightarrow X_L = 100 \Omega$ (1)

b) $X_{LP} = \frac{R_L^2 + X_L^2}{X_L} = \frac{(12)^2 + (100)^2}{100} = \frac{144 + 10000}{100} = 101.44 \Omega$

$R_P = \frac{X_L^2 + R_L^2}{R_L} = \frac{(100)^2 + (12)^2}{12} = 845.33 \Omega$

$Q_P = \frac{R}{X_{LP}} = \frac{R_S \parallel R_P}{X_{LP}}$

$R_S \parallel R_P = \frac{40(0.845)}{40 + 0.845} = 0.828 k\Omega = 828 \Omega$

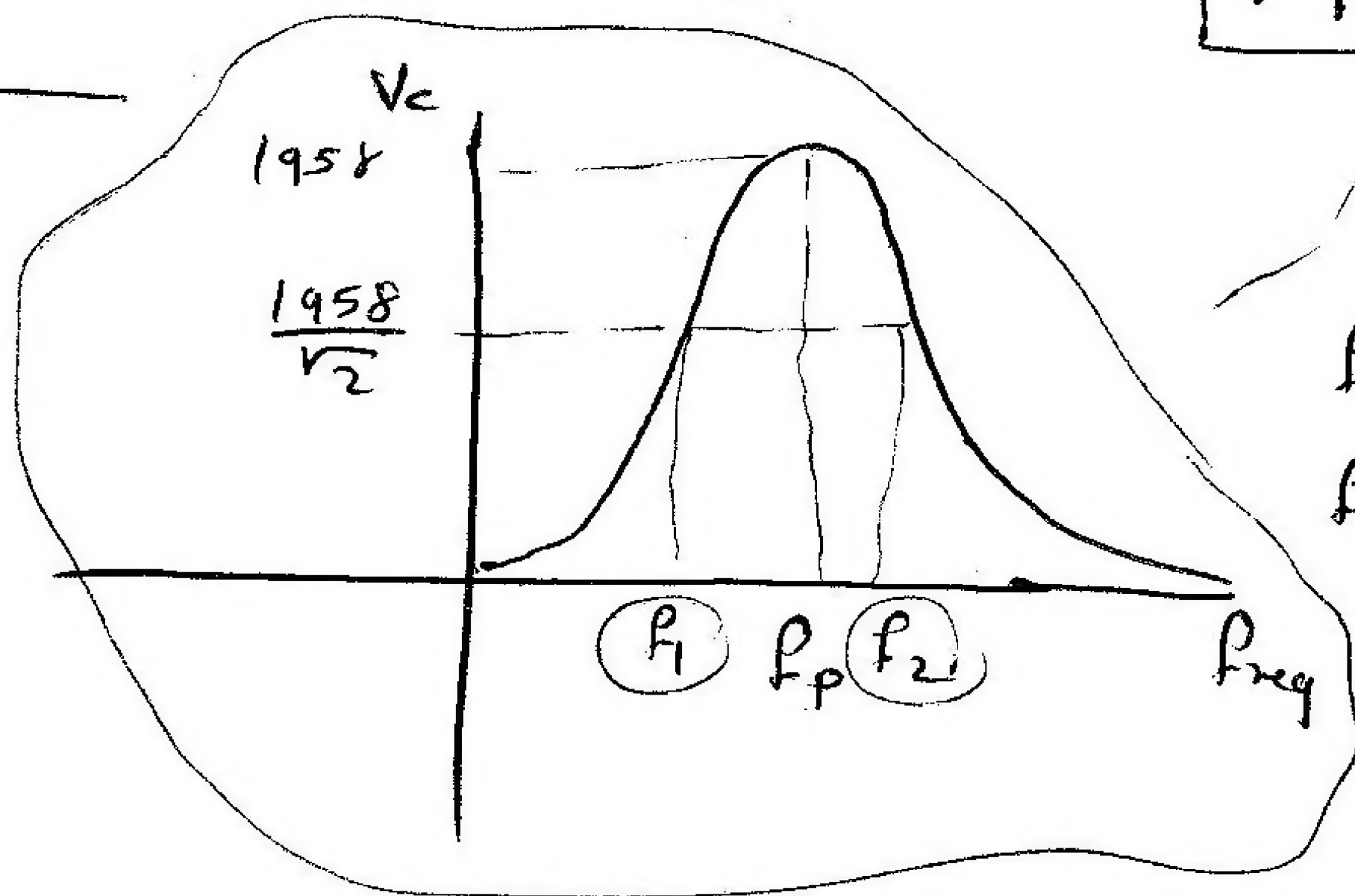
b) $Q_P = \frac{R}{X_{LP}} = \frac{828}{101.44} = 8.16 = Q_L$ (1)

c) $BW = 1000 \text{ Hz} = \frac{f_P}{Q_P} \Rightarrow 1000 = \frac{f_P}{8.16} \Rightarrow f_P = 8.16 \text{ kHz}$

d) $V_C = V_L = Q_P E \Rightarrow V_S = 6 \times 10^{-3} \times 40 \times 10^3 = 240 \text{ V}$

$\therefore V_C = Q_P E = 8.16 \times 240 = 1958 \text{ V}$

e) graph



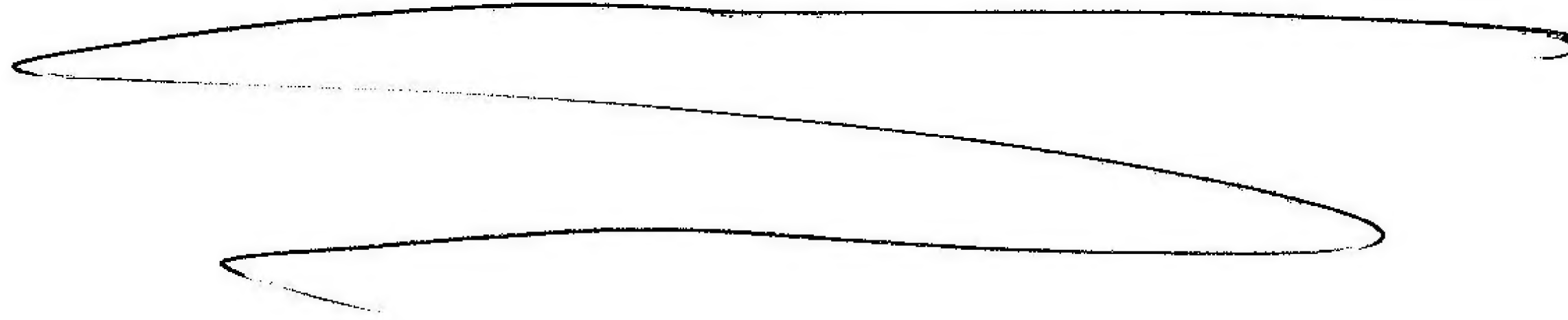
$f_1 = f_P - \frac{BW}{2} = 8.16 - \frac{1}{2} = 7.66 \text{ kHz}$

$f_2 = f_P + \frac{BW}{2} = 8.16 + \frac{1}{2} = 8.66 \text{ kHz}$

②

③ I_C & I_L

at resonance \Rightarrow ~~$X_C = X_L$~~ $\Rightarrow \frac{V}{X_C} = \frac{V}{X_L}$
 $\Rightarrow \underline{I_C = I_L}$



Q4) For the Y-Δ connected system below. If the phase sequence of the generator is ACB and $E_{AB} = 220 \angle 0^\circ$

- What is the magnitude and phase angle of E_{BC} , E_{CA} (1)
- What is the magnitude and phase angle of E_{AN} , E_{BN} , E_{CN} (1.5)
- What is the magnitude and phase angle of I_{ab} , I_{bc} , I_{ca} (3)
- What is the magnitude and phase angle of I_{Aa} , I_{Bb} , I_{Cc} (1.5)

In Y

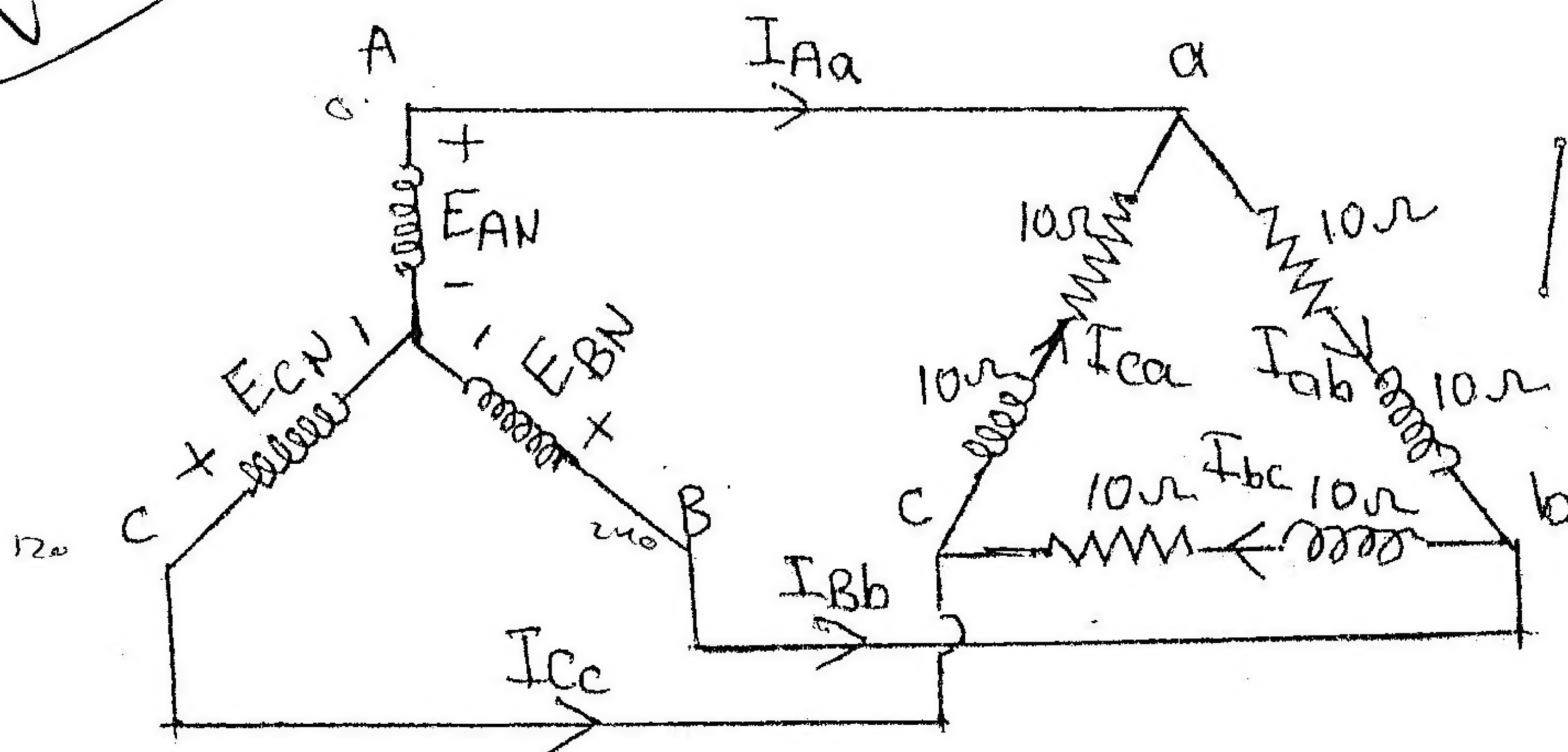
$$I_L = I_\phi$$

$$V_L = \sqrt{3} V_\phi \angle +30^\circ$$

In Δ

$$V_L = V_\phi$$

$$I_L = \sqrt{3} I_\phi \angle -30^\circ$$



$$\begin{aligned} E_{AB} &= 220 \angle 0^\circ \\ E_{BC} &= 220 \angle -24^\circ \\ E_{CA} &= 220 \angle -120^\circ \end{aligned}$$

$$\begin{aligned} E_{AN} &= \frac{220}{\sqrt{3}} \angle -30^\circ = 127 \angle -30^\circ \\ E_{BN} &= \frac{220}{\sqrt{3}} \angle -27^\circ = 127 \angle -27^\circ \\ E_{CN} &= \frac{220}{\sqrt{3}} \angle -15^\circ = 127 \angle -15^\circ \end{aligned}$$

$$\text{here, } V_L = V_\phi \Rightarrow V_L = 220 \text{ V}$$

$$I_{ab} = \frac{220 \angle 0^\circ}{10 + j10} = \frac{220 \angle 0^\circ}{14.1 \angle 45^\circ} = 15.6 \angle -45^\circ \text{ A}$$

$$I_{bc} = 15.6 \angle -45^\circ - 105^\circ$$

$$I_{ca} = 15.6 \angle -45^\circ - 75^\circ$$

$$I_{Aa} = \sqrt{3} I_\phi = \sqrt{3} 15.6 \angle 0^\circ = 27 \angle 0^\circ$$

$$I_{Bb} = 27 \angle +30^\circ$$

$$I_{Cc} = 27 \angle -30^\circ$$

Good Luck
Mahmoud Ahmad